

The University of Chicago

EMERGENT EVOLUTION AND THE
SCIENTIFIC METHOD

A PART OF A DISSERTATION SUBMITTED TO
THE FACULTY OF THE DIVISION OF THE
HUMANITIES IN CANDIDACY FOR THE
DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF PHILOSOPHY

1932

By

DAVID L. MILLER

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Introduction

When such men as Galileo and Descartes gave a general formulation of the scientific method, they also sowed the seeds for the theory of emergent evolution. Although the nature of the scientific enquiry, as formulated by the men of the seventeenth century, implied the acceptance of emergents, their metaphysics was opposed to the rise of anything new. This rationalistic metaphysics, which arose simultaneously with the formulation of the scientific method, tended to assimilate the causal relations in the physical world to the logical relations of inclusion, implication, and equivalence. Obviously, qualities could not be assimilated to these logical relations, but since the Christian soul made possible a habitat for the qualities of the world, they were considered as subjective. Thus, according to this dualistic metaphysics, the world which fell within the scope of the scientist was purely quantitative in nature; but, on the other hand, actual experimentation such as those performed by Galileo himself, presupposed the metaphysical reality of sense qualities. Galileo called upon sense data in order to verify his rationalistic calculations.

According to the rationalistic metaphysics of the seventeenth century, qualitative change was subjective. The essence of the physical world never changed; there was only spatial change which did not affect the identity of the material bodies. All such change was presumably predictable on the basis of the existing motions of bodies. Change, then, brought with it only mechanical resultants; the world was said to be a great machine.

Emergent evolution contrasts itself with that type of metaphysics which is referred to by C. Lloyd Morgan as "mechanistic." This "mechanism" is combatted by the theory of emergence and is said by all emergent evolutionists to imply complete predictability on the basis of present phenomena, and to imply also the logical inclusion of all future reality in present reality. That is, it implies that reality does not change in nature nor increase in amount.

Emergence implies the non-predictability of many events and holds that science fails to "explain" new qualities which arise in any process. Whereas science supposedly equates the

new to the old, the effect to the cause, emergent evolution defends the proposition that there is an epigenesis of new forms in the organic world and new types of relatedness among elements, and that new forms or new types of relatedness cannot be reduced to any former step in the process which leads to them.

"Put in abstract terms the emergent theory asserts that there are certain wholes, composed (say) of constituents, A, B, and C in a relation R to each other; that all wholes composed of constituents of the same kind as A, B, and C in relation of the same kind as R have certain characteristic properties; that A, B, and C are capable of occurring in other kinds of complex wholes where the relation is not of the same kind as R; and that the characteristic property of the whole R (A, B, C) cannot, even in theory, be deduced from the most complete knowledge of the properties of A, B, and C in isolation or in wholes which are not of the form R (A, B, C)."¹

Or again,

"let there be three consecutive levels of natural events, A, B, and C. Let there be in B a kind of relation which is not present in A; and in C a kind of relation, not yet present in B or A. If, then, one lived and gained experience on the B-level, one could not predict the emergent characters of the C-level, because the relations of which they are the expression are not yet in being. Nor if one lived on the A-level could one predict the emergent characters of B-events, because ex-hypothesi, there are no such events as yet in existence."²

These two definitions stress the non-predictability of some events which arise in a continuous process, in contrast to LaPlace, for example, who advocated complete predictability.

It is the purpose of this thesis to illuminate the use of emergent qualities in scientific procedure and to show that an acknowledgment of such qualities is not, and never has been, opposed to the application of the scientific method. An attempt will be made to defend the view that there is nothing mysterious or uncontrollable about emergents from the standpoint of science, and that any causal explanation of emergents, which is external to the environment and the phenomena out of which emergents arise, is unjustified. It will be maintained, further, that science, on the one hand, attempts to find a common denominator in qualitative differences. Such a denominator, however, is sought for the purpose of control in producing still other quali-

¹C. D. Broad, Mind and Its Place in Nature, p.61

²C. Lloyd Morgan, Emergent Evolution, pp. 5-6

tative differences. This does not mean that our ability to predict, say, astronomical phenomena gives us control over those phenomena; rather, it does mean that we are able to adjust ourselves in accordance with those phenomena and to control our activities so as to solve whatever type of problem may arise therefrom. It may be maintained, on the other hand, that science, with emergent evolution, acknowledges irreducible things, which have been called "determinate wholes"¹ or "substantives."² This means that science does not equate a given form to its analyzable parts nor to the process giving rise to it.

Emile Meyerson, in Identity and Reality, has made observations similar to the ones found in this paper, but he puts them to an entirely different use. In contrast to the present view which maintains that science does not assimilate the effect to the cause, that in every equation science presupposes significant differences, and that laws are abstractions from the courses of events, Meyerson holds that science completely equates cause and effect, that every mathematical equation completely identifies the members opposite the equals sign, that laws are purely rational in the sense that no phenomenon conforms completely to law, and, in brief, that such identities as are used in scientific calculations entirely ignore reality.³ Meyerson does not attempt to illustrate the completely consistent relationship between identity and reality, as does the present work; rather, he portrays the view that rationalization, when applied to natural phenomena, does a great injustice to them. He lays great stress on the fact of man's quest for an explanation or an understanding of events. Man, he says, finds an explanation, not in finding the conditions necessary to produce the event in question, nor in a knowledge of events in a sequence, but in completely identifying cause and effect and in equating one event to another.⁴ Thus, a causal series includes not only A

¹R. W. Sellars, "Critical Realism and Substance," Mind N.S. (1929)

²A. E. Murphy, in The University of California Publications in Philosophy, Vol. IX (1927)

³Emile Meyerson, Identity and Reality, English translation. For the principle of identity in disagreement with reality, see pp. 41, 100, 109, 298, 399.

⁴Ibid., p. 43: "Things are thus because they are already previously thus;" p. 146: "in virtue of the principle of causality, our mind shows the invincible tendency to maintain its identity in time." See also pp. 42, 43, and 54.

followed by B but also the equation between A and B. He holds that science ignores time or qualitative change, since change is opposed to identity and does not permit "explanation." He concludes, therefore, that science is inadequate, distorts reality, and, in general, is opposed to what we have defined as "emergents."¹ The present view attempts to put in relief the distinction between reality and the method of treating reality, with special emphasis on the fact that explanation does not consist in equating cause to effect, that rationalization does not consist merely in reducing "new" events to old ones, and that emergents are quite compatible with the scientific method. In fact, it will be maintained that causes are empirical events, that "explanation" consists primarily of an understanding of the conditions necessary for the production of an event, that rationalization consists in finding methodological denominators common to the events correlated, and that emergents give rise to the scientific problems.

Meyerson does not attempt to distinguish between scientific methodology and a metaphysics. It seems, rather, that he confuses the contemporary scientific procedure with its uncritical metaphysical presuppositions, that is, with the metaphysics of such men as Galileo and Descartes, who apparently did not derive their metaphysics from a careful study of the factors involved in the actual application of the scientific method. Reasons for the failure to distinguish between methodology and metaphysics may be found in the historical background of the rise of modern science. The identification of numbers with the essence of reality by the Pythagoreans, and the similar identification of "forms" with reality by Plato and Aristotle, are good examples of this failure to make the distinction. It would also seem possible to adduce psychological reasons pointing in the same direction. For example, some still maintain that mathematical equations reveal the essence of those objects to which they are applied.

Now, when it is made clear that, say, mathematical equations are means of treating admittedly different objects by correlating them from the point of view of control and production, it follows that cause and effect, likewise, are admittedly different events and that our experiences of empirical data in no wise should conflict with the attempt to control them. If laws,

¹Ibid., p. 282: "Now we can understand....how illusory is the sign of equality applied to the representation of reality."

equations, and mechanics, which are agreed to be rationalistic in the sense that man has formulated them by virtue of his ability to generalize, can be shown to be correlated with empirical experiences of what we will call reality, then the purpose of this work will have been accomplished.

CHAPTER I

SUBSTANCE

When we attempt to formulate the historical setting which gave rise to the problems of emergents, we find ourselves starting with early Greek thought. The concept of substance historically marks the line of distinction between investigation and myth.¹ A temporary solution of the nature of substance made it possible for Galileo to give a mechanical interpretation of cosmic processes. But the mechanical interpretation of physical processes demands, above all, an answer to the question: What is "cause" from the scientific standpoint? Although the problem of causation has been made central by some in an attempt to solve the problems of emergence, other questions seem to be of equal importance, namely, What is the nature and significance of process? and, What is a machine? Before attempting to clarify the notion of "cause," "process," and "machine" as concepts used in scientific procedure, let us return to the development of the concept of substance.

The present treatment of substance will deal only with those aspects of it which contribute to an understanding of the formulation of the scientific method and to an understanding of the problem of emergent evolution. As indicated above, the theme of this dissertation will consist in clarifying the relationship between quantity and quality, cause and effect, whole and parts, old and new, rationalism and empiricism.

The early Greeks fashioned the general nature of almost all later Greek thought in their contention that reality does not change, that it is impervious to time. They set the problem for the metaphysician to follow in their attempt to locate the substances which withstand all change. The fact that change and permanence are relative terms not only expressed itself in the philosophy of Parmenides, which holds that change cannot take place in "nothing," but also by Heraclitus, who held that if all is flux the laws of change are permanent. The recognition of the significance of the discovery of the relativity of permanence and change led to a clear distinction between quantity and quality or substance and its attributes. As early as Anaximander we find an

¹E. Cassirer, Substance and Function, English translation, p.151.

attempt to rise in logical freedom above the realm of perceptible reality. Substance, for Anaximander, was not sensuous; it was a homogeneous structure in which the warm and the cold, the wet and the dry lay unseparated. Thus actually, these opposite qualities, whose various mixtures produced all the qualities in the world, resided in substance itself. Therefore, the essential problem for the Greek philosophers was to give a consistent statement of the relationship between substance and its attributes, universals and particulars, quantity and quality.

The Greeks were unable to conceive a purely homogeneous substance.¹ This was because they were unable to identify homogeneity with that which contrasts itself with quality, for example, with the system of measurement used in the scientific method. Even Democritus attributed specific qualities to the atoms. They were round, sickle-shaped, hook-shaped, and so on. This inability to give weight to the distinction between quantity and quality continually haunted the Greek mind in its attempt to state the relationship between substance and its attributes. Modern science was able to overcome this barrier by defining the essential factors in mechanical calculations, namely, space and time, as homogeneous and quantitative in character.

Aristotle distinguished between the being of a body and the qualities which he elevated to separate essences. He held that these essences were transferable from one body to another, at least in principle. For him, the properties which are common to a class of things furnished the foundation for the construction of a generic concept, and were separated off from the physical and raised to independent existence in the sense that they were the forms which matter strove to actualize. The whole of chemistry and alchemy of the Middle Ages becomes intelligible when we understand that qualities could presumably be taken out of things and even transferred to other things by virtue of their independent existence. All bodies were alike in the sense that they were all, in theory at least, bearers of the same quality. To this extent matter was rightfully called bare potentiality by Aristotle. The problem of the alchemists was to discover a process whereby certain essences could actually be separated from bodies so that these bodies would retain only the desirable properties. If these men could master the different "natures," they could likewise im-

¹By "homogeneity" is meant, throughout this dissertation, that which is of the same quality throughout in the sense that the parts involved are additive. By "heterogeneity" is meant that which contains non-additive parts.

print them on matter thus producing valuable metals. For example, they tried to separate tin from its creaking, its fusability, and its softness so that it would approach silver.

The Pythagoreans discovered the technique of the modern scientific method when they incorporated numbers in the concept of substance. For the purpose of the present work it is of importance to note the significance of the Pythagorean use of numbers in making an abrupt distinction between quantity and quality. The discovery that the square of the hypotenuse is equal to the sum of the squares of the two sides of a right triangle resulted in more than a mere discovery. For one thing, it was an assertion that space is homogeneous and that its parts lend themselves to congruency. Furthermore, it was an assertion that numbers, which were additive and to that extent homogeneous, were applicable not only to things but also to substance. The discovery of incommensurables put in question the nature of substance for the Pythagoreans. But for modern thought this discovery calls for a refinement of mathematical technique, and the nature of substance, especially for Galileo and Descartes, remains purely homogeneous.

The attempt to equate substance and numbers by the Pythagoreans, and Galileo's attempt to equate substance with the instruments of measurement and control,¹ are of great significance with regard to the theory of emergent evolution. Above all, it brings out the fact that quantity and quality, homogeneity and heterogeneity, like permanence and change, are relative to each other. Secondly, it puts in relief the fact that what we wish to think of as quantitative and qualitative is a matter of definition - defined as such for methodological purposes. If we bear these two facts in mind, it will help to clarify the discussion to follow concerning the relationship between emergents and the scientific method. Here we may pause to say that the measuring technique, namely, the identification of number with space and time, which are considered homogeneous by modern science, has meaning and significance only with respect to qualitative, determinate wholes, or emergents.²

Returning to the homogeneity of numbers, it is of special interest to notice the manner in which Euclid of the fourth century B.C. consummated the previous speculations on the nature of

¹E. A. Burtt, Metaphysical Foundations of Physics, pp.197-98

²By "determinate wholes" is meant physical objects, which are more than the sum of their aspects. The objects are the bearers of aspects, yet they are not resolvable into attributes. These determinate wholes do not consist of "cores" which have existence independent of attributes.

space. His axioms, equals added to equals gives equals, and the whole is equal to the sum of its parts, are of great importance in the development of the scientific method. These axioms are true by definition, and this brings out the fact that just as the whole is equal to the sum of its parts, by definition, so homogeneity is a matter of definition. We may add chairs and tables together, not as chairs and tables, but as members of a larger, more inclusive, class, namely, articles of furniture. In this case they are additive by definition. In fact, homogeneity and measurability are synonymous terms in the application of the scientific method. Euclid, therefore, did not discover what is metaphysically true of space, but he gave significance to the concept of the homogeneity of space so that this concept might be applied in a scientific production of various configurations, and finally in a scientific control of physical phenomena.

The arbitrariness with which we select certain aspects of the world and define them as homogeneous cannot be too strongly emphasized here. What is meant here, and throughout this dissertation by arbitrariness in selection is that we choose from a world of multiform experiences certain aspects which we believe can be best employed as standards with respect to which other aspects of this same world can be correlated. An example of such an arbitrarily chosen standard is found in the invention of clocks which measure the velocities of bodies, the rate of the disintegration of certain chemicals, the velocities of light and sound, the rate of the fading of colors, and so on. At first crude water clocks and hour-glasses were used for such purposes. But the question arose: Does the water, or the sand, flow uniformly? In order to answer this question, it was necessary to search for motions which were apparently free from the obstacles which hindered water, or sand, from flowing uniformly - such obstacles as varying temperature, pressure, and so on. Hence, by virtue of new astronomical doctrines scientists were led to accept the movement of earth's rotations and revolutions as uniform. But, again, such natural phenomena as tides led to the questioning of the uniformity of the earth's rotations, and it was necessary to search for a phenomenon with less possible hindrances to uniformity. That is, scientists sought for ideal situations in order to find external phenomena corresponding to their a priori conception of "equal intervals." In each case these men arbitrarily chose a standard of time with respect to which other phenomena varied, and each time this standard was selected from physical phenomena. The present Einsteinian definition of equal durations is as follows:

"If we consider a ray of light passing through a Galilean frame, its velocity in the frame will be the same regardless

of the relative motion of the luminous source and frame, and regardless of the direction of the ray. It follows that a definition of equal durations in the frame will be given by measuring equal spatial stretches along the path of the ray, and asserting that the wave front will describe these equal stretches in equal times."¹

We have no proof that this definition of equal durations is final or absolute. We may say, however, that the use of this definition obtains more simplicity in co-ordinating a given set of phenomena than was found in previous definitions. Likewise, it is more efficient in aiding us in prediction; but for this reason, clearly, this definition of equal durations of time is arbitrarily chosen for methodological purposes. One could just as logically choose the rate of the fading of a certain color as a standard, but with far less success in accomplishing the purposes of present-day science. This does not imply that to every purpose there corresponds one and only one successful standard of correlation, for success is a matter of degree. What should be emphasized is the fact that any standard may be employed with some degree of success, and that our choice of such standard is arbitrary.

In modern science our system of measurement and our use of space and time in measurement are no more metaphysically real, as is supposed by Alexander, than the things measured. What is quantitative in its nature and what is qualitative in its nature is a matter of definition. Of course, some aspects of the world, such as space and time, lend themselves more readily and more efficiently as standards in correlating qualitatively different objects, and definitions do not cause the actual differences in the world; but by definition we determine how and according to what standards we shall correlate different aspects of the world. It is as reasonable to say that everything exists in color as to say that all things exist in space. Both color and spatial characters accompany most figures, and certainly spatial characters or configuration does not distinguish one object from another; and although we have chosen space and time with respect to which we correlate other aspects of the physical world, they are no more metaphysically real than the aspects thus correlated.

With this in mind we can see that Galileo arbitrarily divided the experienced world into two distinct parts, the quantitative and the qualitative. To be sure, he did not call to mind every individual aspect of the world and designate it as either quantitative or qualitative; rather, his selection of a method of

¹A. D'Abro, The Evolution of Scientific Thought, p.80.

dealing with his world automatically divided the qualities into these two categories. Whether or not he was conscious of the arbitrariness of this division, is irrelevant; but what is important is that with the aid of Pythagorean metaphysics he was able to assert dogmatically that space and time are homogeneous in the sense that they lend themselves to the complete applicability of mathematics. Galileo did not question the metaphysical reality of space and time. He said: "God geometrizes." Nor did he question the belief that space and time lend themselves completely to mathematical description. However, just as the critics of Pythagoreanism question the applicability of mathematics to space, so Henri Bergson in his Time and Free Will and Creative Evolution claims that "pure Duration" is not homogeneous in the Galilean sense in that it cannot be interpreted in mathematical terms. Here Bergson identifies space with mathematics and holds that both are homogeneous; but to apply numbers to Duration is to spatialize and, therefore, to distort it. Galileo dogmatically asserted that the measurable is metaphysically and objectively real, whereas Bergson, as an anti-intellectualist, holds that Duration, which is not measurable, is metaphysically real. William James, in Essays in Radical Empiricism, writes somewhat from the Bergsonian point of view and places all experience on the same metaphysical level. This is exactly the present view in contending that all experience is of the same generic type, and that what we arbitrarily select as homogeneous and quantitative in character is selected on the basis of the methodology employed.

Hence, we may say, from the standpoint of method, that Galileo was justified in thinking of space and time as homogeneous; but from the metaphysical standpoint he was not justified in thinking of them as ultimately real and objective, as over against sense data which were considered by him as subjective. Emergent evolution rebels most vehemently against the view that space and time are metaphysically homogeneous and real in the sense that there is no qualitative, determinate whole in them. Emergent evolution insists on the metaphysical reality of the qualitative differences arising in physical processes. Such demand calls for a better metaphysical orientation of the scientific method. Likewise, if Pragmatism is to clarify the nature of scientific inquiry, it must stand out against the metaphysics of Galileo and Descartes which arose simultaneously with the scientific method, and which, it seems, has often been confused with the scientific method by emergent evolutionists.

Descartes adhered to the metaphysical dualism suggested by Galileo. He went the whole way in making material substance entirely quantitative and homogeneous. For him all things were

either bodies or minds; substances were either spatial or conscious - *res extensa* and *res cogitans*. At this point Descartes completely identified physical substance with pure extension, which is the same as identifying the homogeneity of the world with the algebraic system. Here Descartes was severely criticized by Locke who maintained that physical substance must possess at least one quality, namely, solidity. The concepts of homogeneity and substance become very interesting here; for if one quality is allowed to house itself in the concept of physical substance, then the identification of substance with pure mathematics breaks down, and a criticism by the empirical minds of Berkeley and Hume was inevitable. Descartes made possible the addition of qualities to the concept of physical substance when he sanctioned the application of geometry to the external world. It is more or less confusing on his part to characterize the inner world as algebraic in character and the outer world as geometric, especially when he attempted to construct a line and geometric figures out of something infinitely divisible.¹ He did not want to reduce geometry to algebra - pure extension to pure thought, yet he wanted to think of space as infinitely divisible so as to rid it of qualities. He tried to construct space out of unextended points. His combining geometry and algebra through analytical geometry not only sanctioned the belief that there is a one to one correspondence between pure thought and pure extension, but it implicitly brought with it the contention that what is true in the purely mathematical realm - algebra or pure thought - has actual metaphysical correspondents in the physical realm. Mathematics gave the true character of the world. Here Descartes identified completely the symbols used in the scientific method of control with the metaphysical nature of that which is to be controlled, the external world. The ensuing conflict between the Cartesian rationalism and British empiricism centered around this point. The empiricists were not willing to grant that concepts have a higher metaphysical standing than sense data, or the qualitative world. Locke's distinction between primary and secondary qualities paved the way for Berkeley's clarification of the relationship between Cartesian rationalism and empiricism. Berkeley, in pointing out that primary and secondary qualities are of the same metaphysical status, made possible the Humean destruction of the rationalistic conception of substance. Hume's work naturally suggests that mathematics serves only as a tool in measuring and controlling phenomena, and that mathematics does not give us the metaphysical nature of the world. Kant was opposed to any attempt to construct space and time out of sense impressions. For Kant, space and time are a priori forms of the

¹This point suggested in G. H. Mead's lectures on Hume.

mind, and to that extent purely rational and homogeneous concepts determining the nature of all empirical data. Hegel attempts to formulate the nature of the world by a priori reasoning entirely:

"Hegel believes that, by a priori reasoning, it could be shown that the world must have various important and interesting characteristics, since any world without these characteristics would be impossible and self-contradictory..... I do not myself believe that anything of importance can be inferred as regards the existing universe."¹

It is of special importance to see that with others Bertrand Russell has made it clear that mathematical method and mathematics itself has nothing whatever to do with the ultimate nature of the existing world. Mathematics is a method and not a metaphysics. The fact that non-Euclidean geometries are also applicable to the world substantiates this point. But if mathematics is a method, and if various systems of mathematics can be developed in accordance with postulates arbitrarily chosen, then quantity and quality are terms arbitrarily applied to different aspects of our world of experience. Thus, when we select certain aspects of the world as standards with respect to which other aspects are correlated, we should not think that only these standards are metaphysically real, thereby confusing methodology with metaphysics.

This brings us face to face with one aspect of emergent evolution. Is it possible to equate the qualitative world of experience to mathematics or to the scientific method as such, so that we have nothing but mere pointer readings in our knowledge about the world? The present view maintains that in some respects it is possible, and even desirable, to equate the sum of the parts of an object or of the world, to the whole; that in some respects the world is homogeneous and in other respects heterogeneous, depending on definitions for methodological purposes, but that we cannot fully equate the qualities of the world to the scientific method or pointer readings; rather, pointer readings have meaning and significance only with respect to sense experiences. It will be maintained, further, that "emergents" as used by C. Lloyd Morgan, Alexander, Sellars, and others, are necessary to the applicability of the scientific method; just as the application of calculus demands definite limits, so the application of the scientific method of measurement presupposes qualitative, determinate wholes. So the problem of substance as something homogeneous, and yet something from which heterogeneity arises, will no longer haunt us. Likewise, the assumption that qualities are "subjective," that

¹B. Russell, Our Knowledge of the External World, p. 40.

space and time are objective or on a different metaphysical plane than "qualities," is unjustifiable. Whether our experiences are subjective or objective is irrelevant; but the fact that they are all of the same metaphysical status is very important.

CHAPTER II

CAUSATION

The assumption that reality does not change nor increase in amount, when accompanied by the inability to conceive of homogeneity as something relative to heterogeneity and as distinguished from it only methodologically, sets the problem of qualitative change as well as the problem of the relationship between substance and its attributes. If reality does not change nor increase in amount, then qualitative change does not affect reality and is in some sense unreal. Likewise, if only the mathematical homogeneous characters of the world are metaphysically real, then qualities with their appearance and disappearance are unreal.

The above difficulty, which presented itself to all philosophers interested in metaphysics from the time of Thales to the men of the seventeenth century, involves the problem of causation. More explicitly, the famous statement that "there can be no more in the effect than there is in the cause"¹ implies that all reality exists now and that tomorrow will not bring a different reality in kind or in amount. Although it seems that this statement has been accepted as axiomatic, its weight has been the source of many difficulties regarding qualities. In general, philosophers have been divided into the "pre-formationist" group and the group which holds that qualities are unreal, unreal in the sense that they are illusory (Parmenides) or in the sense that they are purely "subjective" (Cartesianism). The "pre-formationists" group holds that qualities exist in God, and are, therefore, metaphysically real. Those who believe that qualities are merely subjective hold that they are not on the same metaphysical level with objective homogeneous characters of the world. Both these views involve the problem of causation. The former view finds the causal qualitative change in God, the latter in the relative positions of particles of matter. But at the same time, both of these views ignore the validity of time. For the "pre-formationists" time has no part to play; for the "subjectivists" there is no metaphysical basis for measuring time, since it is only by qualitative differences that we can detect time at all.

The relationship of qualitative change and time to causa-

¹A. O. Lovejoy, "Meanings of 'Emergence and its Modes,'" Proceedings of the Sixth International Congress of Philosophy, 1926, p. 20.

tion may appear very vague, but it will be seen to be quite essential to the present point of view in the light of the fact that our minds tend to conceive of the causal relation as rationally explanatory. That is to say, we try to assimilate the causal relation to the logical relations of inclusion, implication, and equivalence.¹ If causal relations can be assimilated to logical relations, then the proposition that effects can contain no more than their causes becomes true.² But clearly the logical relations of inclusion and equivalence are static and ignore time, or qualitative change by which we are able to detect and measure time. The attempt, therefore, to equate the effect to, or include it in, the cause is possible only when time is conceived of as having no metaphysical significance or when it is considered as homogeneous in character. It is only when we see space and time as on the same metaphysical level with all empirical data that it is possible to find any valid meaning in cause and effect.³ This implies that cause and effect are essentially different in some respects, otherwise we could not say: This is the effect and that is the cause. To say, this - the effect - is the form which the cause now assumes, is an attempt to ignore quality, hence ultimately also time. But since it is impossible to make distinctions in purely homogeneous contents, both cause and effect lose their meaning. And since we can detect time only by qualitative change, it is necessary, for the sake of consistency, to maintain that a cause cannot contain its effects, and, therefore, that causal relations cannot be fully assimilated to logical relations. Empirically there is a difference between cause and effect. But there may also be likeness in cause and effect. The present view maintains that both likenesses and differences are on the same metaphysical plane and that it is only from the methodological standpoint that certain characteristics of both cause and effect can be assimilated to logical relations of inclusion, implication, and equivalents.

A recognition of the fact that the Lockian primary and secondary qualities are on the same metaphysical level and are not different in kind, is a great step toward the clarification of the relationship between quantity and quality, resultants and emergents, cause and effect, methodology and metaphysics. When this fact was

¹Ibid., p. 20.

²Gotshalk, "Causality as an Ontological Relation," Monist, N.S., Vol. 40, p.232.

³This does not mean that space and time as such are metaphysically real; all that is implied here is that their meaning is relative to sense data.

recognized by Mill, he made it clear that causes and effects are phenomena, though separate. He says: "When I speak of the cause of any phenomenon, I do not mean a cause which is not itself a phenomenon; I make no research into the ultimate or ontological cause of anything."¹ Thus, Mill makes a distinction between logical relations, which are of a homogeneous character, and causes. Mill's conception of causes as phenomena ultimately leads to the recognition that measurable aspects of phenomena are no more real than other qualitative aspects. Measurement, rather, is a method applied to the world to produce phenomena at a desired time, and it is not an attempt to do away with qualities.

Mill's concept of cause and effect as phenomenal is also a frank recognition of emergents, for it implies that effects are essentially different in some respects from causes. If cause and effect were entirely alike, there would be no meaning in calling one thing the cause and another the effect. Now, to recognize this difference between cause and effect as metaphysically real is a recognition of emergents. Thus, in modern philosophy, aside from Hume's suggestion that new laws of phenomena may arise in the future, Mill was the first to express the belief in the metaphysical reality of qualitative change. He went so far as to say that new laws of change - not merely our habitual ways of seeing things, as indicated by Hume - may arise in the course of time, and that these laws may be reducible to the "principle of the composition of causes," but that within themselves they conform to this principle. He called these emergent laws "heteropathic laws."² Now, what is to be emphasized here is that sense qualities should be taken seriously in any formulation of a metaphysics suitable to the scientific method. Alexander's suggestion that we should "take time seriously" is a bit misleading. It indicates not only that time is something real in itself independently of qualitative change - which change, according to the present view, is logically prior to a conception of time - but also it suggests that time is on a higher metaphysical plane than empirical data and that all novelty comes out of time as an entity. Both of these implications seem to be ill founded. Not time, therefore, but radical empiricism should be taken seriously. Evolution, like Bergson's "pure Duration," tends to become substantialized in our thinking; but one should be very critical in embracing within the concept of evolution any factor which makes it an entity in itself irrespective of the actual origin of new forms. For example, Bergson makes a Cartesian substance

¹J. S. Mill, A System of Logic, Book III, Chapter V, section 2.

²Ibid., Chapter VI, section 2.

out of time and holds it to be the cause of novelty, while C. Lloyd Morgan and S. Alexander tend to substantialize the concept of evolution, including in it the concept of "Nisus" which is held to be the cause of novelty.¹

To attribute the cause of physical change to anything other than physical phenomena is to make the cause spiritual, or at least non-physical, in character. But the greatest accomplishment for science, of the philosophers of the seventeenth century, was their abandonment of final causes in nature. They despiritualized nature.² For science the rejection of final causes came with the assumption that the causes of phenomena are to be sought among phenomena. Still, Galileo, Descartes, and other rationalists made a metaphysical distinction between qualities as effects and their causes. Locke was within the scope of Cartesian rationalism in making the distinction between primary and secondary qualities and in his contention that primary qualities are the objective causes of secondary qualities. Yet, for Locke only primary qualities were objective, and his attempt to bridge the gap between these metaphysically distinct qualities proved futile. The whole rationalistic movement from Galileo to Kant was based on a metaphysics which submerged the value and objective reality of qualities and stressed the reality of the mathematical or measurable characters of the world. This was a confusion of methodology with metaphysics. What was considered by them as subjective is, according to the present view, objective; and what was considered as metaphysically objective by them is subjective in the sense that we choose, for methodological purposes, to measure experiences according to certain standards.³ If we bear in mind the distinction which has been made here between methodology and metaphysics, it can be seen how science can legitimately define the causes of phenomena as phenomena themselves without contradiction.

Before going further, it is well to define "cause" more precisely from the empirical viewpoint. There are some philosophers who do not believe that we can attach any special significance to the word "cause," for example, Max Verworn, who believes that causation includes the whole environment of any phenomenon.⁴

¹Morgan, Op. Cit., pp. 11, 30, 34, 36, 301.

S. Alexander, Space, Time, and Deity, (1927) Vol. II, p. 349.

²W. Windelband, History of Philosophy, p. 403.

³By objective is meant here that which varies with changes in the physical object.

⁴Max Verworn, Irritability, Chapter II.

Also Bertrand Russell who holds that "causation" is a useless concept in science.¹ Russell's denial of the validity of "cause" follows from his contention that our world is composed of events and not of things. Therefore, he substitutes the functional view for the older concept of cause. For example, if the pressure of gases varies directly as the temperature, then we have, $P = (f) T$. Here the temperature does not cause the pressure, for both are events and, according to the older concept of cause, something more than an event is required to cause another event. He also rejects the use of "cause," since it implies a time interval between cause and effect. This will be discussed later.

The proposed concept of cause is indebted to C. J. Ducasse, but not entirely so. "It is things, and not their changes, which are agents and patients, that is, which do and undergo: on the other hand, it is the changes or the states of things, and not the things, which are causes and effects."² I cannot agree that states of things are causes; rather, they appear to be conditions. On the other hand, there are two types of change which may serve as cause. (1) Any change in the position of a thing. (2) A change in the environment, such as when a cliff drops to a lower level; thus, if one is hiking in the mountains and falls from a cliff, we may say that the abrupt change in the environment is the cause of the accident. A change X of an object or of the environment at large is said to be a cause of a change Y of another object, if the factuality of X was sufficient to the factuality of Y. This use of cause is unwarranted because of the use of "things." The present view assumes that there are determinate wholes (things), but that they cannot be causes except as they change their relation to other things in the system of which they are a part and by virtue of which the "what-they-are" has reality. That is, things are causes in terms of their interaction with other things.

This brings us face to face with two problems concerning emergent evolution. First, are there determinate wholes which cannot be reduced to other determinate wholes? In a later discussion an affirmative answer to this question will be made in favor of the general theory of emergence; but at present we will pass to the second question which is much more acute in relation to the scientific method: Are determinate wholes causes of anything? That is, do determinate wholes as such possess inherent factors which are responsible for the nature of their change and development?

¹Proceedings of the Aristotelian Society, N. S., Vol. XIII, pp. 5, 7, 8.

²J. C. Ducasse, Causation and Types of Necessity, p. 53.

If determinate wholes have such inherent nature irrespective of their environment, then these natures are closely akin to the concept of substance as that which supports its attributes and which reveals them in change. This would be the rationalistic conception of substance, since it attempts to assimilate the causal relation to the logical relation of inclusion. Accordingly, change would not be taken seriously, for it would mean only making explicit that which is implicit. No generically new quality would arise; such qualities, according to this view, are "developed" only. Morgan attributes certain inherent natures to things or to determinate wholes. From his theory it is clear that he believes it to be impossible to get life and mind out of something which does not in some degree possess them. "All systems of events are in their degree psychological."¹ There seems to be an essential relationship between this concept of the inherent nature of things and causation. Morgan makes a distinction between immanent and transuent causes. Immanent causes are due to the intrinsic nature of things, as when water freezes at a certain temperature because of its nature. Transuent causes are due to external influences on a given system.² Now, life and mind were in the world before their specific appearance in organisms; and this is the immanent cause of their arrival; this was the intrinsic nature of the world. But the actual forces which developed them came from without this system, and this is God. There is no conflict between these two concepts, for God gives direction and order to the development of the intrinsic nature of things.

This return to God as the source of all change and development not only implies final cause as an end but also as an end in view, for God as causation does not act blindly. This will be discussed later. What comes to the forefront here is the problem of the relationship of the "intrinsic nature" of the world as it is today and as it will be when further development takes place. That is, are all qualities always in things or in the world in some degree, even before their advent in specific forms such as life and the fact of reflective thinking? To begin with, can we say that it is of the nature of gunpowder to explode under certain conditions as over against, say, iron? The present view gives a negative answer; and this implies that change is taken seriously. Let us see how this can be.

If, according to the scientific method, we define a given object, we must define it with respect to other objects. It is not

¹Morgan, Op. Cit., p. 26.

²Ibid., Lecture X.

natural that gunpowder explodes when in isolation. There must be a cause for the explosion. Likewise, drugs are not poisonous in themselves, but in relation to some organism; to others they may not be poisonous. It seems legitimate to generalize on the basis of what we mean by "thing" and to say that it is a substantive.¹ Things contain no inner core, nor do they have meaning independently of other things. If one asks what a given thing is, say, an orange, we must define it with reference to other things such as our own organisms, its relation to the earth (weight), and so on. A substantive, then, may be defined as that which can acquire aspects when brought into relation with things or other substantives. It is by these aspects, however, that substantives are known; yet, a substantive is more than a collection of aspects. One knows the specific nature of a substantive only by the relationships or the characters which it assumes in relation to other bodies or things. We have an "if - then" relationship in finding just what these characters are. For example, if I peel an orange, then it will appear thus and so; if I taste it, then it will be sweet. We are justified in saying that an orange is not sweet, yellow, round, heavy, and so on, irrespective of its relation to other things. Likewise, we are not justified in attributing an inherent nature to a thing, nor in attributing all of its possibilities to it as actualities without reference to the time-factor necessary for actualization. Nor, again, should we forget the fact that an actualization of one possibility may destroy all other possibilities. This criticism holds it to be a futile and meaningless question to ask what a thing is irrespective of all relations.²

It should be clear from the above that things have characters only in relation to other things and that a thing is not at any one instant a bearer of all of its possible characters. A drug may be both harmful and helpful to the same person, but not at the same time. This is the same as saying that one thing, say,

¹The term substantive has been taken over from A. E. Murphy's article, "Substance and Substantive," The University of California Publications in Philosophy, Vol. IX (1927).

²The word "meaning" as used throughout this dissertation includes more than any present status of an object. The orange may not be sweet now because no one is tasting it, nor is it yellow when no one is looking at it, and so on. That is, an orange is potentially sweet, yellow, and so on. A meaning has reference to what a substantive may acquire as characteristics; yet it may be impossible for the object to acquire all these characteristics at one time. We should not confuse meaning with actualized characters.

a patient, when brought into relation with another thing - medicine - changes the environment of both. Or again, this view maintains that things are more than their constituent parts in relation. To add some quality to an object changes the environment of it and, therefore, all things within the environment are changed. This is no more nor less than the contention that change should be taken seriously and that changes cannot be reduced to resultants or to the past out of which they arose. Energy, velocity, acceleration, and the weight of our planet are defined with respect to other astronomical bodies. But it is held by the theory of relativity that Newtonian gravitation no longer exists. What we can say, however, is that the presence of a celestial body changes the environment so that the nature of space or the shortest distance between given points is different by virtue of the presence of that body. But since velocity, energy, and so on, are dependent on the nature of the environment for their meaning, we may say that they are functions of the presence of celestial bodies. Likewise, the qualities of substantives are dependent on an environment for their meaning, and the environment is a function of other things. Here we should distinguish between a bare thing, events, and meaning. In brief, meanings go beyond events in that they are symbolic, thereby referring to the capacities of a thing as over against the "what-it-is" at any given moment. Also, meanings, in contrast to events, must attach to things. Data as such are always returned to things when they become systematized.¹

The import of the discussion on causation is the clarification of the relation between things and their environment. Both have significant meaning only with respect to each other. Just as a thing becomes this or that in different environments, so an environment is determined by the advent of things and their relation to each other. Something happens to the old environment when life and intelligence enter upon the scene. Similarly, it is a mistake to assume "that the object of knowledge is the same within and without the mind, that nothing happens to what is to be known when it by chance strays into the realm of conscious cognition."²

It is of great significance that things, as we usually think of them, have symbolic references to their potentialities attached to them. The object yonder becomes a chair when one sits in it; it becomes fuel when we burn it; but it is neither of

¹For the clarification of the relationship between data and things, I am indebted to Professor G. H. Mead, especially his lectures on "The Philosophy of Eminent Scientists" and "French Philosophy."

²G. H. Mead, in Creative Intelligence, by Dewey and others, p. 200.

these now. This implies a functional relationship between things and their environment. Yet, things are logically prior to change, and it is changing things that produce changes in or of other things, for if the "what-a-thing-is" is determined by bringing things into relation with other things, then things are the bearers of these relations.

Since things acquire aspects when brought into an environment which is a function of things in relation, and since a thing takes on different aspects in different environments, it is incorrect to speak of the inherent natures of things, as if the thing as such were responsible for the aspects acquired. But if we take change seriously, we must maintain the view that things become other things, and that the "what-a-thing-becomes" is new and was not in any sense contained in that from which it came. There is no need of saying that life, mind, and spirit were in some sense in matter before their advent in specific forms. Therefore, the relationship between a thing and its environment, or the world at an instant, which is a sort of radical empiricism, should be the basis for a metaphysics for science. To get meaning into the world, however, it is necessary to include time or change; for meanings go beyond the immediate present into the "what-the-world-may-be." The validity of the specific references to the future which is implied in meaning is based on past experiences with the fundamental assumption that the world is orderly, that is, the assumption that the world is, when brought within the scope of reflection, a machine.

It is a common assumption among emergent evolutionists¹ that because the present cannot be reduced to the past, nor emergents to their constituent elements, "there is more in the effect than in the cause." This is fallacious. There is not more nor less in the effect than in the cause, nor are causes and effects "equal"; they are simply different, for it has already been agreed that emergents are non-additive. To introduce additive terms is a refutation of the definition of emergents. But if change or, less technically, time brings qualitative results, in what sense is the world quantitative, or in what sense can it be said to be a machine?

¹Morgan, Op. Cit., p.8.

CHAPTER III

THE NATURE OF A MACHINE - THE MECHANISTIC PHILOSOPHY

Emergent evolutionists rebel against Classical mechanics because it seems to interpret world processes in terms of resultants only, and because it claims theoretically to be able to predict future events on the basis of present phenomena.¹ Since the mechanical philosophy is identified with the scientific method, the contenders for emergence picture the scientific method as inadequate, claiming that science does not account for novelty and that it is unable to predict these emergents. In this chapter it will be assumed that emergents are not resultants, if we define resultants as qualitatively similar to their components; it will be assumed, further, that emergents cannot be predicted, but an attempt will be made to show that neither Classical mechanics nor quantum mechanics is infected with these two claims. Also, it will be shown that the functioning of a biological organism is not essentially different from the mechanical motions of celestial bodies.

What is the meaning of "Classical mechanics" or "mechanism"? In general the following definition seems to be the uncritical conception of mechanics:

"The distinctive characteristics of mechanical processes is that the course of events in the sequence is rigidly determined. Given a certain set of antecedents, one and the same series of consequences will follow every time. If the total conditions of a situation at a given instant are known, the results can be predicted unequivocal."²

In Science and the Modern World Whitehead contrasts Classical mechanics with his proposed "doctrine of organisms."³ He says that according to Classical mechanics

"each molecule blindly runs. The human body is a collection of molecules. Therefore, the human body blindly runs, and therefore there can be no individual responsibility for the action of the body. If you once accept that the molecule is

¹Ibid.

²Howard C. Warren, "Mechanism Vs. Vitalism in the Domain of Psy.," Philosophical Review, Vol. 27. p. 597.

³p. 116.

definitely determined to be what it is independently of any determination by reason of the total organism of the body, and if you further admit that the blind run is settled by the general mechanical laws, there can be no escape from this conclusion."¹

These quotations bring out the main features against which emergent evolution makes its attack. These features which are charged against Classical mechanics are: (1) Complete determinism; (2) complete predictability on the basis of present phenomena; (3) blind procedure of constituents in a system, along with the first mentioned accusation, namely, (4) new effects are resultants of their causes.

A thorough analysis of Classical mechanics with reference to its application in scientific procedure will show that these four claims against it are either very misleading or totally unfounded. The Galilean-Cartesian metaphysics has been analyzed already and rejected in Chapter I; but the actual scientific method advocated and employed by both Galileo and Descartes, with other men of the seventeenth century such as Boyle and Newton, is quite adequate to deal with emergents; in fact, emergents are necessary for its application.

Boyle wrote a treatise on The Excellence and Grounds of Mechanical Philosophy. In Siris Berkeley evaluated this type of mechanism by saying that "the mechanical philosopher enquires properly concerning rules and methods of operation alone, and not concerning the cause; for as much as nothing mechanical is, or really can be, a cause."² Aside from the fact that Berkeley attempts to restore final causes to their medieval status, his recognition of mechanics as a method is of import. The mechanics of Galileo, Descartes, and Newton should not be confused with their metaphysics. Since these three men held essentially the same world-view,³ and since the Newtonian Laws of gravitation and the mechanics are a culmination in clarity and precision of the mechanics of the Renaissance, Newton's formulation will be accepted here as representative of Classical mechanics. This will be supplemented when necessary, however, by presuppositions implied in actual applications of mechanical principles.

Classical mechanics is, above all, constructed on the theory of the inter-dependence of natural events on each other for meaning. Inertia, velocity, force, weight, mass, and so on have

¹p. 115.

²Sec. 249.

³E. A. Burtt, The Metaphysical Foundations of Physics, p. 230.

no specific meaning irrespective of bodies in relation.¹ Every natural event is set in a system. Energy is a coefficient of the whole situation or of a system as such, and it is derivatively applied to specific elements. The whole system must exist before individual bodies have significance. Because of the faulty metaphysics of the Galilean-Cartesian-Newtonian world-view² Newton attempted to illustrate the distinction between external and internal relations. Internal relations represented, supposedly, the "what-a-body-is" in itself - immanent causes of its ability to have independent characters.³ External relations are purely mechanical, and these are of interest here. Newton defined mass in terms of volume (internal relations) and in terms of inertia (external relations). But in exact measurement it is impossible to determine volume by internal relations; for one cannot determine it irrespective of other bodies. The "what-a-thing-is-now" may be thought of as so much quantitative matter, but if we want to measure volume or inertia, we must do it with reference to a system. Newtonian bodies attract each other directly in proportion to their masses and inversely in proportion to the square of the distance between them. Likewise, acceleration is a function of distance and mass. This reveals what may be called, from the internal-relational point of view, the sensitivity of bodies to their environment and to other bodies, and from an external-relational point of view, the inter-dependence of bodies on each other for their meaning.

A realization of the "sensitivity" or inter-dependence of objects, carries with it an acknowledgment of the Whiteheadian "organic" character of Classical mechanics. An analysis of the fact that every Newtonian object has a functional relationship with an environment will show that determinism, predictability, and resultants may be applied with equal meaning to both Classical mechanics and Whitehead's proposed "doctrine of organism," as well as to emergents which are held by some to be foreign to the scientific method. Whitehead is quite Newtonian in saying that "molecules differ in their intrinsic characters according to the general organic plans of the situations in which they find themselves."⁴ His contention that molecules run blindly in accordance with general laws, is misleading; for just as an "organic" atom is a function of its environment both in meaning and in the manner in

¹Isaac Newton, Principia, section on Definitions.

²Burt, Op. Cit., p. 263 ff.

³Newton, Op. Cit., Book III, Problem XXII, General Scholium.

⁴A. N. Whitehead, Science and the Modern World, p.115.

which it functions, so is every mechanical body.

"Classical mechanics recognizes that every natural event is set in a total situation, of which the event in question is part and from which it is abstracted for particular consideration. The event is an equilibrated dynamic process or a disturbance of equilibrium with a tendency to return to equilibrium. In its very essence it is what it is because of the situation in which it finds itself."¹

Morgan's contention that an atom, an organism, and a person are instances of relatedness and that it is "as an integral whole of relatedness that any individual entity, or any concrete situation, is a bit of reality,"² stresses the other aspect of Classical mechanics, namely, that there is no reality irrespective of a system.

In view of the fact that both Classical mechanics and the newly proposed theory by Whitehead and others are "organic" in nature, what application can complete determinism, complete predictability, and resultants have to any part of the world, from a living creature to the celestial bodies at large?

(a)

Determinism

Determinism may be used as a concept from two points of view. It may be used to imply that the future activity or state of a thing is a function of present factors. These factors may be present either in the sense that they inhere in the nature of the thing, or in the sense that some external plan in the form of law or end in view is imposed upon the thing. From the standpoint of the scientific method this use of determinism seems to be fallacious.

A second meaning of determinism is that every future activity or state of a thing may be found to have come about in an orderly fashion. To find the world orderly does not imply that there is a rigid plan or a law apart from specific events, and which specific events must follow. Rather, it means that phenomena bring with them a uniform pattern which may be detected by us and called "law." It means, further, that things, in their courses, respond to every immediate situation in accordance with their environment and the nature of their past. For example, a body's response to another attractive body will depend on their respective masses and the distance between them, but also on the acceleration, which is an accumulation of the body's past history. This use of

¹C. J. Herrick, "Mechanism and Organism," Journal of Philosophy, Vol. XXVI, p. 591.

²Morgan, Op. Cit., p. 67.

determinism is scientifically legitimate, but somewhat misleading. It gets its significance, in application, through the proposition that the world is orderly in the sense that in the main phenomena will repeat themselves. This is "a proposition which we hope is true,"¹ and it carries with it no such suggestion that things are mere puppets unable to respond to their environment, and whose courses are determined by something external to them. Probably we should do away with the word "determinism," and say that we have found order in many phenomena and that we hope it can be found in all phenomena; or we may say that every phenomenon is believed to reflect order (a law). Consequently, just as the latter use of determinism has been in vogue in science with reference to celestial bodies, so it is also legitimate with reference to atoms in themselves - including Quantum mechanics - and to every living creature. It follows that just as the new "doctrine of organism" pictures atoms as pursuing their courses with reference to a system, so bodies of Classical mechanics may be likewise treated with equal meaning and justification.

(b)

Prediction

One purpose of science is to make predictions on the basis of hypotheses formulated from empirical evidence. The relationship between empirical data and hypotheses reveals itself in the form of a problem. A conflict in experience constitutes a problem, and the problem may duly be considered as an emergent. It is an emergent in the sense that the conflicting experience as yet has no orderly connection with past experiences or with the past as such. An hypothesis is a formulation of an ordered past for the emergent in order to bring it within the scope of law, as well as within that of cause and effect relations. Such an ordering of the past of an emergent consists in reconstructing the conditions in space and time which are believed to be essential to the rise of the emergent in question. But the mere formulation of an hypothesis is not enough in science. The hypothesis must serve not only as a possible explanation of the manner in which emergents come about; but also it must serve in many cases as a prediction of future phenomena under similar circumstances, and its truth or falsity depends on its success or failure respectively in prediction. If nature does not already furnish the conditions necessary in testing hypotheses, then man, if it is within his power, may establish the conditions.

¹C. S. Peirce, "The Doctrine of Necessity Examined," Monist, April, 1892.

In view of the fact that evidences of the uniformity of nature prove the postulate that nature is uniform only up to date, it is clear that prediction cannot be absolutely certain. It has been found, however, that when an hypothesis works in one instance it works in other instances irrespective of the time element. At present it is essential to note that hypotheses serve as a basis for prediction and that every hypothesis comes about as an attempt to resolve conflicting data into a systematic whole. But does science claim to be able to predict the entire future of any object or of all things? Does it pretend to be able to predict the entire future on the basis of a thorough knowledge of all present factors of any one fact? When we remember that hypotheses, and therefore predictions, have to do with specific events and specific aspects of nature, it is clear that prediction does not deal with all future phenomena nor is it interested in the entire future. The very nature of the proof of an hypothesis excludes the possibility of complete prediction; for it attempts to isolate the present problem from irrelevant circumstances. Hence, a complete knowledge of the "flower in the crannied wall," from a scientific point of view, would not yield a complete knowledge of all future phenomena. With reference to a complete knowledge of the future of the flower in itself, that, too, is impossible; for it presupposes that one hypothesis embraces all the various aspects of the flower and that these aspects are, therefore, intimately related. Science has no such presupposition. Scientific knowledge has to do with the testing of hypotheses concerning specific problems. Furthermore, scientific knowledge does not consist in an unfolding or in a development of mathematical equations such as the binomial theorem developed to the n -th term. Rather, science formulates new hypotheses which are different in type from the old ones; for the latter cannot account for the emergent. "Every new theory must take up into itself earlier doctrines and rationalize the earlier exceptions."¹ Thus, science thrives on problems and each problem implies that the former hypotheses, which are the bases of prediction, are inadequate in accounting for the emergent involved in the problem. Therefore, according to the scientific method, to claim complete predictability does an injustice to the purpose of the modern scientist.

(c)

The Nature of Resultants

Emergence, as represented by Morgan, contrasts itself with the mechanistic interpretation which gives a resultant effect only,

¹Dewey and others, Creative Intelligence, p. 217.

and does not, he says, acknowledge that "something more" which must be accepted as emergent. He writes, "such an interpretation (e.g., of life) is quite inadequate. Resultants there are; but there is emergence also."¹ The question which I will attempt to answer in the affirmative, is this: Is not the "something more," which is said to be emergent, accounted for in the mechanical resultant used in science? A clarification of the relationship between resultants and emergents is one of the main purposes of this dissertation, and the contention is, therefore, worthy of expansion.

Probably the best illustration of a mechanical resultant is found in what is known as the sum of two vectoral forces having a common origin. In this case the amount of each force and its direction is represented by the magnitude and the relative position of the corresponding vector. The completion of the parallelogram with reference to these vectors, which may be called (a) and (b), will determine the resultant (c), which is the vector drawn from the origin of (a) and (b) to the point on the parallelogram opposite the origin. If we measure the resultant's magnitude, it will be found to be different from the sum of the independent lengths of the vectors (a) and (b), except in the special case where (a) and (b) have the same direction; yet, the resultant is said to be exactly equal to them in one sense. (C) is equal to (a) and (b) in the sense that if it were reversed in direction, it would exactly neutralize (a) and (b). Thus, (a) and (b) are equal to (c) by definition and by virtue of a functional relationship. But if we respond to the resultant of two forces as it exhibits itself in nature, then this response is in a sense essentially qualitatively different (but not necessarily "more") from a response to (a) as such plus a response to (b) as such, for here time enters in; but if (a) and (b) are considered parts of a closed system or parts of a whole, then the response to (c) is, by definition, equal to the response to (a)-plus-(b). To define (a) and (b) as homogeneous additive parts of a whole, does not mean that our response to (a) and then our response to (b) - the responses taking place at different times - is the same as our response to (c). Rather, our response to (c) is one response, and it is a response to (a)-plus-(b), or to (a) plus (b) analytically. But analysis destroys (c). Admittedly, in our response to (a) plus (b) and in our response to (c) there is equality in difference; for methodological purposes there is equality; nature furnishes differences.² The (c)-response

¹Morgan, Op. Cit., p. 8.

²See pp. 60-61.

(a response to the resultant) must be qualitatively different from the responses to (a) and (b), if there is to be equality; but in calculation or in the application of measurement, the time element and this difference of response are held in abeyance. Mathematics, or any scientific measurement, which claims to deal with a homogeneous field, presupposes and holds in abeyance the qualitative world of differences. That is, if X equals Y , there must be something in the perceptual world corresponding to both X and Y if the equation is to have meaning and before it can function. Although mathematics is able to deal only with likenesses, yet these likenesses presuppose non-additive units. A unit, by definition, is not found within a homogeneous field; it is always qualitative. The homogeneous field as a whole may be qualitative, since it is a unit; but within that field there is no difference essential in giving significance to "quality," for "quality" is a relative term depending on other differences for its meaning. Within a purely homogeneous field - which is a contradiction - there is nothing which has meaning. Rationalization, and hence meaning, depends on equalities in differences. Hence, resultants are in a sense equal to their components, but they are also different in a very significant sense. In the sense that a resultant is analytically equal to its component parts it is their mere sum; in the sense that it is different it is an emergent.

Since the relationship of resultants to emergents is a central issue, it will be well to exemplify this relationship, showing also the relation of the scientific method to qualitative differences.

If two equal volumes of water, h and c , have a temperature of 60°C and 20°C respectively, a normal person would get a displeasurable sensation, if he bathed in either. But if we combine h and c , getting a temperature of 40°C , one would get a resultant sensation qualitatively different from that obtained from either h or c . The resultant would not be two displeasurable sensations nor a sensation twice as displeasurable as that obtained from h and c separately, but one pleasurable one. This seems to substantiate Bergson's contention that sensations are in a significant sense qualitatively different and not additive when taken one by one at different times; but if we consider h and c as parts of a system (a whole), both working together at the same time, then we can consistently say that the resultant sensation, which is pleasurable, is equal to the sum of the sensations received from h -plus- c .

Again, if we add equal bodies of water, h and c , the volume will be doubled; but the resultant temperature will be the mean temperature. If we add bodies of water of the same tempera-

ture, the temperature will remain the same. Or, if like shades of color are mixed, the color remains the same in quality; but if unlike shades are mixed, the resultant effect will be qualitatively different from either. This is true of all "secondary" qualities, but not of space. Now, the reason that space does not vary qualitatively in the same manner as do "secondary" qualities, is that scientists have accepted space as the normal with respect to which other qualities vary. Space has been accepted as that which is to be treated as homogeneous in order that other qualities may be controlled with respect to it. Space lends itself to such use because it is a quality applicable to every physical object. But even in space, nine feet is three times three feet, only operationally or analytically, and there is a sense in which nine feet as such is qualitatively different from three feet. Every multiplication brings an emergent. Resultants there are, but there are emergents also.

These facts illustrate the former contention that qualities such as space and time, to which mathematics has been so adequately adapted, should be considered not as the only real factors in the world. That is, those qualities which are especially selected for methodological purposes should not be confused with metaphysical reality; nor should we confuse these qualities with our method of measuring them. In any calculation where common denominators are involved, such as space and time, we must hold in abeyance the things equated, or completely ignore the time factor so essential to dynamical physics. This dissertation proposes that we should recognize qualitative change or time, thereby recognizing the metaphysical reality of the things equated. We should and must, in a dynamical world where things are defined in terms of their interaction with each other, take qualitative change (time) seriously.

(d)

The Relation of Continuity and Process
to Determinate Wholes and Emergents.

Leibniz attempted to solve the problem of the Cartesian dualism between mind and matter by maintaining that their difference is not one of kind but one of degree only. All monads, except God, possess each a soul and a body; the former is the relatively distinct perception, the latter is confused perception. Leibniz well illustrated the theory that soul and body are different only in degree, by his development of the infinitesimal calculus. His use of process and continuity in mathematics and his application of these two concepts to body and mind, to organic and inorganic matter, to plants and animals, and so on, is the first attempt in modern philosophy to treat experiences, whether reflective think-

ing or sense data, as of the same generic type. His definition of the essence of every monad, however, as a spiritual force whose ultimate goal is pure perception, is a definition of reality in terms of the goal or the process, on the one hand, and a reduction of matter to a lower metaphysical level, on the other. This sort of relationship between soul and body does not allow them to be entirely alike in kind. But for the present purpose it is probably more significant to note Leibniz' recognition of time in an unfolding of reality or in the monad's approach toward perception. Darwinian evolution seems to imply that time can do wonderful things toward bringing about different biological forms. But the time element is employed in different senses by Leibniz and Darwin. Leibniz uses time in order to bring body and mind together and to resolve them into one generic type, whereas Darwin uses time to account for the actual origin of the species. Leibniz' recognition of a goal or direction in process and his definition of reality rationalistically, in terms of the goal, however, is an acknowledgment of actual differences in time in the status quo of the individual monad. It would be more consistent to accept mind and body as equally real and to maintain that change brings about new reality. It is a confusion to say that the reality of the monad is in the monad and, on the other hand, to say that a monad realizes its actualities in a continuous development in time, in which development perception becomes clearer and matter is sloughed off, and to maintain also that soul and body are not different in kind but in degree only. Leibniz did not take process seriously, but used it as a means of resolving apparent differences. But an important question remains: Does the use of continuity and process reduce steps within that process to the same generic type? Leibniz implied an affirmative answer to this question, but, once again, it seems that this is an identification of mathematics or method with the metaphysical nature of the world.¹ Process has no meaning irrespective of qualitative differences. For example, the equation for determining the velocity of falling bodies, $V = gt$, has no meaning unless we can substitute actual values for two of the symbols whose values determine the value of the third. Hence, process substantialized, or "evolution," is not a legitimate way to resolve all differences to unity. Every different biological form must be acknowledged as such, and the value of process and continuity must be sought in their effectiveness in explaining the origin of forms and in bringing them about.

¹G. M. Duncan, Philosophical Works of Leibnitz, Chapter XI.

The conception of identity in science belongs to mathematics. Leibniz attempts to preserve identity in process. The inner content of the Leibnizian monad remains the same. Leibniz did not recognize that change or process brings something altogether new. The fact that emergents can, in a sense, be resolved into a neutral-stuff, such as Newtonian energy or pure mathematics, and that they can also be treated as irreducible differences, is what gives meaning to identity in difference. But to hold that there is no emergent is simply to ignore time. To equate an emergent to its components implies a recognition of time, but to treat an emergent as if it functions as its component parts, is illegitimate in that it ignores time altogether. Thus, where there is process or development we always have differences given, and for purposes of measurement and control there is identity also. Archimedes' attempt to attain knowledge by balancing one thing against another, shows his inability to conceive of identity in process; and it also brings out the fact that the temporal element did not enter into his type of knowledge. For him, effect and cause were of the same temporal span. This type of knowledge is not erroneous but limited. Until we are able to come back to an identity in change, we, too, cannot be said to have knowledge. But in change both identity and differences must be fully recognized. A statement of the nature of a process is a law which comes back to experience. The law itself maintains a functional identity wherever it is applied. The actual situation to which a law is applied may be quite unusual, and to that extent qualitatively different from other situations, but the law maintains a functional identity. For example, $V = \frac{gt^2}{2}$, may be applied to situations in which g varies greatly, but in that case V will vary correspondingly. It is this functional identity and qualitative difference which gives rise to the meaning of things in process. The above equation remains meaningless unless specific values are assigned to the variables. Likewise, any set of measurements, such as space and time, have no meaning irrespective of content; much less do they have a metaphysical status far above that which they measure.

Now, since process has meaning only in relation to identity in difference, it is essential that we be able to refer to differences in process so as to have specific meaning. To say that there is an infinite number of points in a line, does not give qualitative meaning to the line. But to single out a specific point and to say that it is one inch from another specific point does give qualitative significance to a part of the line. That is, one inch is a unit of length, and, therefore, qualitative in nature; for distinctions are always qualitative. Thus, it is very essential to make assignments among an infinite number of points lest we have

no meaning, for meaning is qualitative in nature. Since the infinitesimal calculus is applicable to processes in nature, so that it is possible to posit an infinite number of stages between, say, the ignition of gunpowder and the completed explosion, we must not believe that any assignable stage is exactly like any other assignable stage, however close they may be. It is illegitimate to substantialize law or process and to maintain that identity is within process or the law as such. Rather, identity remains throughout the functioning of a law. Thus, we can get rid of none of the differences by positing an infinite number of points and stages in a process between any two assignable stages or points. An assigned point is different from any other point among an infinite number. Process, therefore, does not do away with novelty or determinate wholes. Any assigned point or stage in a process is a definite qualitative distinction in the sense that perception can operate only with qualitative differences, and it is in the field of perception that we have determinate wholes and not in a homogeneous field. From this standpoint every determinate stage in a process is an emergent also. Not only because we perceive things as units are they wholes, but any application of the infinitesimal calculus demands determinate wholes. Mathematics may be useful in helping to bring phenomena about, but it can never give us the content of that which happens, for useful mathematical symbols refer to, but do not include, the qualitative.

To summarize: Continuity and process are inseparable concepts used in stating the conditions necessary for the origin of certain present forms to which the process (law) is applied. But because two stages in a process - which stages may be considered as forms - have been brought under the same law, we are not justified by this fact in holding that two forms are different only in degree. If we maintain that forms that fall within the same law are of the same generic type, we have substantialized the law, thereby making all of its possible contents of the same substance. On the contrary, the present view maintains that every demarcated stage in a process is qualitatively different by virtue of its unique place in a qualitative series of events, that it is, therefore, an emergent which is irreducible to other stages in the same process, but having a common denominator with other stages only in the sense that a functional identity remains in the law which is applicable to all of them. Emergents are, therefore, indispensable in a process, for qualitative change, which gives the nerve to process, is not a compilation of homogeneous units, but a development of something qualitatively different from forms found in earlier stages of the process.

(e)

The significance of the mechanistic philosophy, which acknowledges time through the use of process and continuity as over against Archimedian physics, lies in this fact: It is able to deal with an object in relation to an environment and in relation to its past. That is, a body which conforms to mechanical laws has meaning only within and in relation to a system, and its past is accumulative in the sense that it conditions the body's present relationships. Mechanical bodies are not predestined in their courses; rather, like the cells of a biological organism, each step in their progress conditions the next step. Likewise, mechanical bodies or machines are not resultants save by definition and from a methodological point of view. In other words, a machine, like a Whiteheadian organism, is able to condition and re-condition itself most exactly in accordance with the demands of the environment which is inseparable from the machine in question. If man cannot fully adapt himself to the demands of his environment, he is an imperfect machine. But just as man cannot be reduced to adaptation, so innate mechanical bodies cannot be reduced to mathematical equations.

Those who maintain a teleological explanation of the origin and functioning of an organism such as, say, man, must be able to point out what that purpose is. To say that God has prevised the course of man, is not an adequate explanation. One must, in that case, be able to state God's purpose and to show that man by his own nature is able to fulfill that purpose. If a description of the goal cannot be given, then nothing is added to the scientific quest; but if a formulation of the goal is made, we have discovered a law among phenomena; and this law turns out to be a scientific explanation. Driesch's experimental indeterminism apparently does not permit such an explanation in terms of purpose, and it is an admission that there are phenomena among which we have not yet found order.

CHAPTER IV

THE USE OF EMERGENTS IN THE SCIENTIFIC METHOD

Science thrives on problems. That is, we live in a world in which the new and the unresolved are constantly confronting us, and these are the factors in which science is primarily interested. However, if the contingent or even the merely unexpected events in our experiences were of the same general nature as objects in our past experiences, we could not call them emergents in the sense that we would have to formulate new hypotheses as to the nature of their origin. If one were calculating the areas of figures, he would have to apply a different formula to circles than to rectangles. Likewise, in discovering new phenomena scientists are often required to formulate new hypotheses to account for them. This implies that at least many scientific problems are not solvable by classifying the new conflicting experience in Aristotelian fashion or by seeking for a denominator within the new experience which is already known to exist in past experiences. Rather, a new formula must be made which will account for the conflicting experience and embrace the old laws which were unable to account for the emergent. Emergents are, therefore, admittedly unpredictable. But if the business of science is to formulate and test new hypotheses in order to account for the unforeseen new experiences which conflict with past experiences, as over against classification and the expansion of formulae already in existence, then there is no difference between Morgan's concept of an emergent¹ and that which affords a scientific problem. For the scientist a conflicting experience is contingent and by definition unpredictable. That is, prior to the moment of its first appearance it was unpredictable; but upon its appearance, an hypothesis is constructed with reference to the conditions of its appearance; and, hence, the predictability of the emergent is established by the success of this hypothesis. It is the business of the scientist to resolve the once unpredictable into that which can be predicted, and the truth or falsity of his hypothesis lies in its success or failure, respectively, in predicting that which was once contingent. If the hypothesis meets with success, then the once unpredicted event becomes predictable.

Thus, in science, we have contingencies or emergents which

¹C. Lloyd Morgan, Mind at the Crossways, p. 15.

are found in conflicting experiences, on the one hand, and science attempts to resolve emergents into predictable events, on the other. If emphasis is laid on the fact of emergence alone, we neglect the fact of prediction. If emergents are denied by saying that everything is predictable on the basis of present phenomena, then the chief business of science is destroyed and we substitute in its place the classification of events and the expanding of equations. Both the fact of emergence and prediction are essential to scientific procedure.

The justification for hypotheses which state the condition under which emergents arise or can be produced, lies in the assumption that phenomena are orderly. The belief in the proposition that like causes have like effects or that the world is orderly, is the same as the belief that every emergent has an ordered past which was the necessary condition of its appearance. Both beliefs imply that from some point of view emergents can be resolved into predictable events. As far as human intelligence is concerned we have no basis for even venturing to formulate laws of the origin of the emergents before these emergents appear. We find order in phenomena, and we cannot formulate laws concerning the origin of phenomena before they make their appearance to us.¹ To say that we have nothing but experiences of phenomena keeps us within the realm of strict positivism and does not allow the formulation of hypotheses which become laws when they are tested and found to be true; for hypotheses apparently always fasten to things and not to mere events. It is true that scientists bring their world to individual experiences and sensations, but they do not keep it there. Should the scientist interpret the world in terms of conflicting experiences, or his data, which are emergents, then the positivist would be correct in reducing the world to mere phenomena. But the scientist formulates hypotheses which are the means of returning to the object. The data, which appear in the problem, are used in breaking down the old world, but an hypothesis formulated on the basis of those data is an attempt to reconstruct the old world. Hence, emergents or conflicting experiences enter in as a tearing-down process, but laws are reconstructions. If emergents alone are stressed, we remain within positivism or at the first stage of the scientific procedure, and we do not make prediction possible in any sense, nor do we permit data to become meaningful aspects of objects in an environment. The foregoing chapters may lead one to believe that there is nothing in the scientific world but aspects of things

¹C. J. Herrick, The Thinking Machine, p. 162.

Mr. Herrick's view of science is quite sympathetic with the present treatment of emergents.

and that the present view ends with radical empiricism. But radical empiricism only furnishes the data which are returned to things or determinate wholes upon the formulation of hypotheses. When data are related to each other and to an environment, they become meaningful aspects of things and are no longer exceptions unaccounted for and outside of a system by virtue of which we have objects.

The scientist may set up as his task the rationalization of emergents (that is, the formulation of hypotheses which describe the emergent as that which necessarily follows from an ordered past), or he may set up as his goal the production of the new (the invention) which will satisfy some demand. In either case, whether he attempts to find an ordered past for an emergent, or takes the role of an inventor, the scientist comes back to a neutral-stuff.¹ In rationalizing an emergent, however, one does not perfect the old world but creates a new one which takes the old world up into itself. Rationalization implies a neutral-stuff or a common denominator among those things brought under a common system. But modern science assumes that there is no phenomenon which will not bear rationalization, and the Aristotelian accidents (emergents) are the data for rationalization.² In rationalizing an emergent the scientist does not merely add another page to the history of events, but he shows that the entire history should be re-written from the point of view of present data. The ancient world did not attempt to re-write the past or invent new objects. For the men of that world there was nothing new under the sun, and their only task was to perfect the world in which they lived. In modern science the concept of prediction and invention set the background for a mechanical world in which we recognize a common denominator (a neutral-stuff - for the physicist it is energy) applicable to qualitatively different objects. This common denominator or neutral-stuff is identified with method and should not be confused with the metaphysical reality of that to which it applies. It is for the purpose of predicting and very often controlling phenomena that common denominators are useful. The Epicureans used the Democritean atoms in order to rid the world of pain and undesirable qualities; but for the modern scientist to be able to find analytically in things a common denominator, does not mean that things are reduced to, nor that their reality consists in, a neutral-stuff. Just as there are differences in mathematical likenesses, so there may be likenesses in qualitative differences.

¹By a neutral-stuff is meant a common denominator, such as electricity, which expresses itself in various forms under various conditions.

²Dewey and others, Op. Cit., p. 209.

Emergent evolutionists hold that science cannot reduce the new to the old and that there is no common denominator between new forms and old ones. I believe that this is not the whole truth nor the important fact about science. Rather, science holds in abeyance these irreducible differences, but always presupposes them in any calculation. Nor does science attempt to explain the fact of qualitative differences; it attempts to, and is successful in, bringing about these differences to quite an extent. A further proof that science does not fully assimilate qualities such as life and matter to each other nor to mathematics, is brought out in the fundamental purpose of science, namely, problem-solving. Every problem means that something new (qualitatively) has arisen, or at least has gained attention. That which makes something new is the fact that it cannot be accounted for by old laws. Thus, science sets out to find a denominator common to the old and the new. But the new is not destroyed by such analysis; it is systematized, recognized as real, and conditions of its prediction and reproduction are set up. The "new" is welcomed by scientists, not that they may belittle its reality and assimilate it to mathematical equations, but that it may direct them to that which will gratify some special need. This recognition of the emergent, and the attempt to predict or reproduce it, shows that scientists mean by resultant what Morgan means by "something more." Here, again, such a thing as electricity, for example, is used in order to produce various effects such as the heating and lighting of homes, cooking food, propelling vehicles, transmitting sound, etc., but never are these effects assimilated to the cause. Here we have a common denominator in various qualitatively different phenomena, and in invention the scientist accepts these differences as real in themselves.

It is believed by emergent evolutionists¹ that the contention that emergents are not mere re-arrangements of chemical elements carries with it the conclusion that emergents remain emergents, and cannot be rationalized. If we retain the belief that rationalization consists in completely assimilating qualities to a quantitative statement or to the logical relations of inclusion, equality, and implication, then it is true that emergents will not

¹C. L. Morgan, Emergent Evolution, p. 8.

bear rationalization.¹ But rationalization for the scientist consists in formulating the nature of a past which sets the conditions necessary for the advent of the event in question. If the velocity of a body is known, it is possible to reconstruct a past for that body out of which its present velocity necessarily issues. The formula for reconstructing such a past does not engulf the falling body in the sense that the latter loses its specific qualitative values. Rather, the specific event in question gives meaning to the general formula. That is, $V = gt$ is, as it stands, an empty formula, and unless definite values are assigned to the variables it has no specific content or meaning. Rationalization in the above example does not consist in assimilating the velocity as such to gravitation and time; it consists in abstracting certain mathematical features from velocity, gravitation, and time, and in showing their exact correlation as well as constructing a past on the basis of that correlation, which can account for the appearance of that specific velocity. The application of chemical, physical, and mathematical symbols to phenomena or to biological forms, should not be interpreted as an identification of those symbols with that to which they are applied. Symbols are merely signs of things and are not the things for which they stand. The confusion of symbols with that for which they stand seems to be common to almost all who propose a theory of emergence.² That is, they assume that the application of such symbols does injustice to emergents either by distorting them or by reducing them to elements found analytically. In general, many scientists have been called "mechanists" because they are alleged to have assimilated completely the object with which they deal to the symbols used as a means of controlling and predicting these objects.³ But if we bear in mind clearly the distinction between means and end, or method and reality, it is evident that all scientists acknowledge

¹~~Meyerson~~, Op. Cit. Throughout this book ~~Meyerson~~ maintains that emergents will not stand rationalization, for rationalization, to him, means that one thing is identified with another, that, e.g. the cause is identified with the effect (pp. 41, 43, 146-47, 219), and that the old is identified with the new. Rationalization, however, is of a different nature than this.

²Bergson best expresses this view in his claim that any measuring of time distorts it.

³I owe this thought to G. H. Mead's original manuscript of the Paul Carus Foundation Lectures, which I had the privilege to read before their publication.

the things with which they deal as in some sense real and as irreducible to the means of controlling them, whether or not they profess such acknowledgment in their doctrine.

The method used in predicting and controlling phenomena may be developed quite independently of any phenomenon. For example, Hamilton's quaternions, vector analysis, tensor analysis, and Einstein's equations, which were later applied to physical phenomena, along with many other special mathematical concepts such as the square root of minus one, brings out this fact. Whether or not these concepts can be applied to phenomena is a different matter. Just because some concepts which were developed independently are applicable to phenomena, should not lead us to believe that the inherent nature of phenomena is identical with such independently developed concepts, far less should we believe that these concepts exhaust the reality of phenomena. Emergent evolutionists have accused scientists of claiming complete predictability of the future. Aside from the statement of LaPlace, it seems that such men base their accusation on the scientists' presupposition that the number system with its equations may be expanded endlessly so as to embrace the events for all time to come. But since it is recognized that the development of a new type of mathematics or the formulation of a new mathematical concept does not tell us anything about the nature of the existing world,¹ and certain mathematical concepts are not applicable to certain phenomena so that other concepts must be formulated, we can be assured that complete predictability is impossible from the standpoint of mathematics. Furthermore, it is obvious that prediction has to do only with specific events or with specific phases of events, and not with all phenomena.² That is, scientific symbols are applicable to limited fields and not to everything at once. A simple example will make this clear. The time of an eclipse of the sun can be predicted; yet in spite of this prediction scientists set up their telescopes and spectroscopes in order to observe special features about the eclipse which were not predicted nor predictable, but which may serve as data for a new hypothesis concerning the physical nature of the sun, and so on. But these new data do not necessarily have any relative connection with the eclipse as such; they have not to do with the prediction of eclipses, but with other things quite removed from them. Thus, the ability to predict an

¹Russell, Op. Cit., p. 40.

²Dewey and others, Op. Cit., p. 219.

eclipse is far removed from the ability to state the physical nature of that which is eclipsed; nor does an eclipse and the nature of the body eclipsed necessarily have any relevant connection which would bring both within a single formula.

Science, then, has as its working material or data emergents which we have defined as that which is not embraced in any old law but which affords an opportunity for a new hypothesis which states the conditions necessary for the origin of the emergent in question. An hypothesis maintains a strategic position, for it serves as a means for both production and reduction. As a means for reduction it describes the past as that of which the emergent is a function, and such a functional statement is represented by mathematical symbols which are homogeneous in character. For example, in a statement of the past conditions necessary for the present velocity of a body we have the equation $V = gt$, where V represents the velocity, g gravitation, and t time. Now, V , g , and t are qualitatively different in character, but corresponding to them are numbers which are homogeneous in character in the sense that they are additive; hence such an equation represents both quantity and quality. The quantitative aspect of the equation implies the reduction of the dependent variables to a common denominator; e.g., numbers. These variables are controlled in order to bring about the production of variously qualitatively different states or conditions. Thus, common denominators (numbers) are used in production, invention, and in bringing about the qualitative. Heat, light, and electro-magnetic energy have been reduced to a common denominator; but all of these are actually qualitatively different when considered from the point of view of our different responses to each.¹ An hypothesis finds in familiar experiences a denominator common to the emergent. This denominator may be called a common stuff because of its quantitative homogeneous character, but it serves as a basis for producing qualitative effects and often a multiform of variations which are in themselves irreducible things, but which, in turn, lend themselves to a common method whose symbols are quantitative in nature.

There seems to be a feeling among emergent evolutionists that in some manner the cause of a synthesis which gives rise to a qualitatively different event, must be in some manner embraced within the formula which states merely the order of the appearance of events in a given situation, if that formula is to be considered adequate.² That is, an adequate statement must tell not only how

¹W. Windelband, An Introduction to Philosophy, p. 136.

²C. Lloyd Morgan, Mind at the Crossways, Introduction.

an event arose, but why. According to the foregoing definition of cause and the exemplification of rationalization, one is not justified in inferring that the concept of cause applies to anything other than the series of events themselves. It cannot refer to something outside of the series of events. P. W. Bridgman, in The Logic of Modern Physics, states that it is meaningless to ask: "Why does time flow?" and "Why does nature obey laws?"¹ These questions are meaningless because they, by their very nature, exclude the possibility of an answer. Accordingly, one cannot look for causes outside of phenomena themselves; and if we attempt to argue from analogy that nature's patterns, such as the six-pointed snow-flakes, imply purpose and an end in view,² owing to the demand of human activities for explanation through some purpose, we again misuse the concept of purpose. If the intelligence of man which gives rise to purpose is only functionally different from the physical nature of the world, then purpose must be kept within the data of experience. Thus, it is meaningless to ask: What body or agent outside of experienced phenomena caused or purposed these phenomena?

This reference to cause and purpose is made here because the foregoing consideration of the relationship of emergents to hypotheses and science in general, may appear inadequate in that it does not account for "creative synthesis"³ or "emergent evolution" itself. But the actual nature of rationalization and explanation from a purposive or causal point of view cannot meaningfully, it seems, extend itself to something metaphysically different from our own general type of experience. This means that purposes and causes of phenomena must be sought among phenomena; the problems of nature must be solved in terms of nature and the concept of mechanism must be capable of including all phenomena which are found in nature, as over against the contrasting of this concept with supernatural forces which are alleged to play a part in nature. By definition, and for other substantial reasons, supernatural forces cannot make their way into nature. It is the business of science to state the conditions under which emergents arise and to test such statements to see if they correctly predict or produce that which once was an emergent but which, upon its prediction or reproduction, becomes embraced within a law. The facts of emergents and science are in complete harmony; for emergents are the data of science. But when emergents are brought within the scope of successful hypotheses, they can be predicted or repro-

¹pp. 30-31.

²C. Lloyd Morgan, Mind at the Crossways, pp. 2, 13, 42, 259.

³Spaulding, The New Rationalism.

duced; and their reproduction places them within the domain of predictability, which by definition relieves them of their emergent characters.

CHAPTER VI
THE CONTRIBUTIONS OF THE GENERAL THEORY OF EMERGENCE
TO THE SCIENTIFIC METHOD

(1) One of the greatest contributions of the general theory of emergence, also called "evolutionary naturalism" (Sellars), "creative synthesis" (Spaulding), "emergent vitalism" (Broad), and "organicism" (L. J. Henderson), is that it has brought novelty, qualitative change, and time to the front in any formulation of a valid metaphysics for science. The scientific method has always implicitly accepted qualitative change and novelty as metaphysically real, but the special metaphysical doctrines such as "mechanism," "materialism," and "naturalism" have reduced scientific data to the method of treating them, or to the elements which compose the complexes giving rise to novelty and change. These doctrines sought to reduce everything to the least common denominators applicable to them, assuming that reality lay in these denominators only. They were dominated by the method of science with its stress upon quantities. Such doctrines, in their zeal for analysis, did not recognize sufficiently the fact of synthesis. This implied that qualitative change was a sort of distortion of reality and that analysis restored reality to its proper status, whereas emergence maintains that the reverse is true. Instead of recognizing things as deriving their meaning from a system, the above doctrines tried to reduce the system to the things. But, clearly, if there is a system to be interpreted in some manner, this system is in some sense real. Likewise, if there is analysis, there must be something to be analyzed. The present view stresses the fact that no two things can be entirely equated and that all scientific data are equally real metaphysically. Atoms, elements, and common denominators cannot be elevated in meaning or quality to the complexes which they form, nor can complexes be reduced to their constituent parts. This does not imply that something is added when complexes are formed; there is just something different which comes into being, and this difference in a qualitative sense is non-additive.

The concept of process as formulated by Leibniz, Newton, and others was legitimately used later as a basis for both differential and integral calculus. When applied to differential calculus this concept suggests that components are more real than the whole, e.g., a circle is composed of an infinite number of

triangles, or bodies tend to move along the paths of straight lines unless disturbed by external forces; as if triangles and straight lines were of a higher metaphysical status than non-triangular figures and curves.¹ When applied to integral calculus this concept suggests that process does not produce a difference in generic type and that all the members of a series in a process differ only in degree. For example, it is often implied that if we can show a continuous unbroken series between animals and plants, then there is no generic difference between them. Emergence, however, maintains that there is no more reality in elements than in complexes, that process implies a goal toward which the series is moving, and that within a continuous process there are determinate wholes different from those found in previous or later stages in the same process. That is to say, in any process such as the movement of a falling body any calculation of a future position of the body presupposes a goal toward which the body is moving. Likewise, when we cut into "process" in applying definite velocities and times to bodies, we have, not velocity or time in general, but a specific determinate velocity or time.

A recognition of the metaphysical reality of process and determinate wholes not only shows that qualities are not to be considered as merely subjective, but that causal relations are to be sought in qualitative change, and not in a "quantitative" substance, nor are they to be assimilated to logical relations.²

(2) A due consideration of qualitative change and sense data helps to clarify the distinction between metaphysics and methodology. It also helps to show their relationship. The Cartesian assumption that pure extension comprises matter, excludes the possibility of attributing quality to matter, since the pure extension of which Descartes spoke was identified with method and quantity. On the other hand, the attempt by Morgan and Lovejoy to consider at least some "secondary" qualities as emerging when mind and matter are brought together in certain relationships, does not allow us, from the present view, to assume that such qualities belong solely to the mind or to matter, or to either; all we can say is that such qualities may be emergents under these conditions, and if they are, then they belong to the total situation. Neither Morgan nor Lovejoy is justified in accounting for qualities by saying that they arise from a relationship between mind and matter, for both are functionally re-

¹See Plato's Timaeus, 48e - 56c.

²Dewey and others, Op. Cit., p. 71.

lated; thereby both are interdependent for their special meaning and cannot be spoken of as absolutely independent factors. But the import of such an attempt to account for qualities of any sort lies in a recognition of the metaphysical reality of these qualities. Once qualities have been given proper consideration in science, metaphysics clearly distinguishes itself from the mathematical, chemical, and physical symbols used in methodology.

(3) The general theory of emergence calls attention to the fact that some of the characters of every complex are different from any of the characters of the elements constituting the complex. There are some characters of water which are neither like oxygen nor hydrogen. To say: water equals H_2O , does not deny the fact that water is different from hydrogen and oxygen in some respect; but it states that water is hydrogen and oxygen analytically, or rather that water can be broken up into two elements. But, as has been stressed throughout the course of this paper, any equation presupposes at least one difference between the factors equated. Thus, even from a methodological point of view we can be assured that no thing, or such determinate wholes which we have called things, can be fully assimilated to its analytical parts or to a detailed description which stands on the opposite sides of the "equals" sign from the thing. E.G., the chemist may say, water = H_2O , but this only tells us what are the constituent elements of water. Or, one may describe water as fluid, drinkable, tasteless, colorless, solidifies at zero degrees Centigrade, and so forth. But such characteristics are of something which is admittedly different from any or all of them in some respects. This may be better stated by saying that weight, color, form, size, temperature, malleability, and so forth, are concepts or universals which are quite meaningless unless they are characters of a specific thing. The questions which may arise here, but which are irrelevant to the present statement, are: Do determinate wholes which possess these characters differ metaphysically from the characters themselves, and are determinate wholes just logical constructs? These questions are pertinent, but for the present it is essential to stress only the fact that particular things with which we deal from day to day cannot be exhausted by universals. Objects are more than statements about them, and any physical, chemical, biological, or practical description of them cannot do away with their determinateness or uniqueness to which universals attach. Any analysis or characterization presupposes something which is analyzed or characterized. This is why universals cannot make particulars, and why parts and aspects as such cannot make a whole.

From above discussions one may be lead to believe that the

metaphysical reality of differences as such has been overstressed at the expense of likenesses which have been said to have no metaphysical standing, but are valuable only for methodological purposes. Now it should be made clear that our actual experience of likeness is as metaphysically real as that of difference; but we must bear in mind that the differences which we experience in objects (which differences imply likenesses of the same metaphysical status) are quite unlike the common denominators which scientists apply to these objects. A simple example will make this clear. If one experiences blue as different from red, or as like it, this experience of likeness is of quite a different nature from the scientific likeness. For the scientist, likeness between colors consists in similarity in wave lengths and the velocity of light (the spatio-temporal factors), or in the fact that the length of waves and their velocity can be computed in terms of numbers which are alike, as previously stated, because of their homogeneous character. But our ordinary experiences of likeness in colors cannot be so measured, as has been shown by Bergson in Time and Free Will, because they are absolutely unlike from the point of view of mathematics. Methods of treating experienced objects, therefore, present a different kind of likeness than is found in actual sense experience, and it is just that kind of likeness which has no metaphysical reality, for it is not found in any sense in our sense experiences of objects.

Again, common denominators such as electricity, heat, energy, etc., are concepts which, when applied to specific objects, resolve these objects into mere pointer readings which can be interchanged and substituted for one another at will. Hence, unless we hold in abeyance or keep in memory those objects which are specific as over against general concepts applied to them in method, and which are experienced by us each separately so that each experience is different, then they are completely submerged in the mathematical sea and all of their metaphysical reality is likewise lost. Methods or pointer readings, then, have no metaphysical reality since they are not a part of the objects which they treat, e.g. two is not a part of two men.

(4) The theory of emergence has helped us to recognize to a more significant extent the place of novelty in the scientific method. The explicit acknowledgment of novelty as something unpredictable has opened the door to progress for science, for such novelties are the essential factors in the formulation of new hypotheses whose function it is to lay the bases for a world of variations and differentiations suitable to the fulfilment of our various needs. The scientist gladly recognizes novelties, only because he hopes to state the conditions of their origin and repro-

duce them, thereby bringing them within the scope of law.

A full recognition of novelties as unpredictable should not lead one to believe that they have no definite cause nor that their happening is only probable. Every phenomenon, it is hoped, has a cause and definite relevant circumstances under which it happens. When these circumstances and the cause are known, then the establishment of them renders the once emergent event necessary, and not probable. Probability gets its import from the fact that some, and not all, of the necessary conditions for the occurrence of the events in question are known, while others are admittedly not known. Thus, one may legitimately ask, what is the probability of A's taking place, when some of the conditions necessary to its taking place are known to exist? Hence, what is the probability of this specific man committing suicide when we know that one out of every ten thousand men do commit suicide? To answer that the probability is one ten-thousandth in this case, does not mean that a specific suicide has no cause. Rather, the life history of every suicide reveals the necessary conditions and causes of the self-murder. The general concept of emergence does not hold that emergents have no known causes, nor that their occurrences are in that sense only probable. What emergence stresses is the non-predictability of emergents, and not the probability of their occurrence. We should not, therefore, confuse the theory of emergence with theories of probability. Probability is a relationship between a remote and general act, necessary to the occurrence of an event, and the event in question. For example, in order that a coin fall to the earth, it must in some manner be tossed into the air. No doubt the specific manner in which the coin lands is conditioned by the position from which it left the hand and the nature of the force exerted in making the toss, besides other factors, such as gravitation, rotation of the earth, and so forth, which remain relatively constant. So, whether a coin lands tails up or heads, is definitely conditioned and caused by the specific nature of the above-named factors; but the specific nature of these determining factors are scarcely ever known. Only the general act of tossing up the coin is usually known, and this necessary act can be correlated with the possible results, so that we may say that the chances of the coin's landing head up is $1/2$ under the general conditions that it is tossed upward.¹ It is theoretically possible, however, to construct a tossing machine accurate enough so that we could tell beforehand how the coin would land. In this case probability would vanish. Every actual event is not probable, it just is. Probability has

¹M. Cohen, Reason and Nature, pp. 125-35.

nothing to do with the intrinsic nature of events, but about evidence for their happening. So, probability does not pertain to the intrinsic nature of emergents. The general concept of emergence, if accepted, will not force us to accept indeterminism, nor more probability in science than is found there independently of emergence. In fact, the theories of probability and emergence have been developed quite independently of each other.

(5) The concept of emergence, although it has been developed to some degree through pragmatism, helps pragmatism in developing a consistent metaphysics. The acknowledgment of determinate wholes and qualities as metaphysically real is quite in line with the central ideas found in William James' Essays in Radical Empiricism and A Pluralistic Universe. Emergence does not stop with radical empiricism, but certainly the data of radical empiricism is essential to emergence and to a metaphysics of pragmatism. Epiphenomenalism as such is rejected by pragmatism, as it is by emergent evolutionists. "With pragmatism's rejection of epiphenomenalism I wholeheartedly agree." It is quite evident, further, that pragmatism rejects the metaphysical doctrines of such men as Galileo, Descartes, Newton, Kant, and others to the extent that it rebels against their quantitative interpretation of reality. The real world in which we live must be interpreted in terms of our successful responses to it. Intelligence cannot operate successfully in an entirely homogeneous field, and in human conduct our world takes on meaning. Things cannot be reduced entirely to quantitative statements, but their meaning and significance lie in the manner in which they function with reference to human conduct and other things. Pragmatism, like the general concept of emergence, holds that experienced things are primary in the formation of an adequate logic or of a general philosophical doctrine;¹ and Sellars, in Evolutionary Naturalism,² has suggested many factors essential to a pragmatic metaphysics. In general, such realists as Alexander, Morgan, Sellars, Spaulding, Bergson, and Broad may be said to have taken effective roles in helping to rescue metaphysics from older quantitative statements and methodology, and so have furnished material valuable in re-enforcing pragmatic contentions.

¹Dewey and others, Op. Cit., pp. 70-118.

²Chapters X, XI, XII.

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